



## Watershed Wisdom

**Overview:** Forests protect watersheds by preventing soil erosion and maintaining the quality of surface water by reducing sediment and other water pollutants. Forests absorb water which is released slowly to plants, streams and groundwater supplies.

### Classroom Activity:

- The class conducts experiments comparing runoff and groundwater recharge on simple models of vegetated and barren mountain slopes.

### Objectives:

Students will be able to:

- Predict the amount of runoff and groundwater recharge on models of vegetated and nonvegetated mountain slopes.
- Measure the amount of water collected in the experiment and compare it with their predictions.
- Draw pictures and write captions contrasting the effects of rainfall on a forested and on a barren slope in Hawai'i.

### Time Recommended:

- One or two class periods.

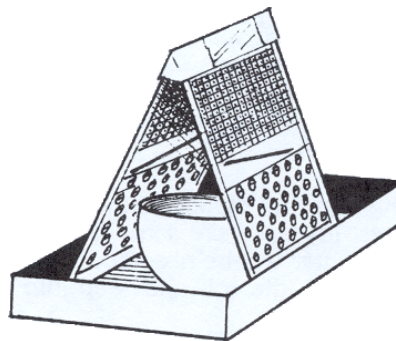
### Materials Needed:

- 9 x 13 in foil tray or pan
- 2 sponges
- 4 rubber bands
- 2 rectangular, flat vegetable graters
- glass or clear plastic measuring cup
- small bowl (to fit inside foil tray)
- spray mist bottle full of water
- blue food coloring
- old towel or newspapers
- masking tape

**Hawaii Content Standard  
Correlation (Geog./Science):**  
Physical Systems, Historical Perspectives,  
the Physical Environment

### Preparation

Use the graters to make an A-frame with the small holes on the top. Bend one of the handles so that the two graters will fit securely together. Cover the long, wide holes with masking tape. Put the foil tray on an old towel or newspapers, and then place the small bowl between the graters in the center of the tray. Add a few drops of blue food coloring to the water in the spray mist bottle. Wet the sponges and wring them out in preparation for the demonstration.



### Teacher Background

Forestry in the Hawaiian Islands began in the mid-19th century when King Kamehameha III declared that "forests and timber growing therein shall be considered government property, and under the special care of the Minister of Interior. ..." In the next half century, various private and governmental efforts were made to encourage reforestation. All this was in response to the general decline of native forests due to uncontrolled grazing, fires, cutting for firewood, clearing for farming, and the invasion of introduced insects, plants, and diseases.

The Hawaii Sugar Planters' Association (HSPA) was a leading proponent of good forest management once it recognized the impact poor management had on the water supply. Sugarcane requires vast amounts of water for irrigation, and most of this water came from mountain streams. The decline of forests was associated with a sharp drop in the quality and quantity of water downstream. It was during this period that the importance of forests as

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watershed reserves became apparent. Watersheds are areas that drain to a particular body of water.

Rainforests act like sponges. Tall trees capture drifting rain and clouds in their leaves and branches. The water drips down to the lower forest layers where some is evaporated and some drains into the soil. Some of this water will be absorbed by roots and transpired through leaves. Some will percolate through the soil and seep into the water table below, and some will drain into streams.

The floor of a rainforest is covered with decaying organic material, ferns and mosses. It is so spongy that even hours after a rain it is still very wet. Water absorbed by this spongy layer during heavy rains is available to streams during times of drought. This guarantees a constant, pure water supply for stream plants and animals. Hoofed animals like cattle, sheep or pigs can significantly damage the forest floor by removing vegetation through grazing or digging and by compacting the soil. They also pollute the water supply with their wastes. Without the forest cover, heavy rains result in soil erosion and flash floods. The eroded soil is carried downstream to the ocean where it can smother reefs. When there's no rain, streams may run completely dry.



eucalyptus forest

When reforesting the watersheds, foresters tried to use introduced species that were not valuable for timber so that later generations would not be tempted to cut the trees. They also experimentally planted many species from other parts of Asia and the Pacific. As a result, native forests are now found only in the most remote mountain areas.

Two of the most widely planted trees, Cook pine

(which resembles Norfolk Island Pine) and eucalyptus, are now common throughout the lower reaches of the forest. Unfortunately, there tends to be no **understory** (the lowest layer of plant life in the forest) associated with these trees. They actually secrete toxins that discourage the growth of understory plants. While these trees are a major improvement over bare soil, they don't provide adequate habitat for native plants and animals, and they may be less satisfactory in watershed protection because their understories are often less complex than native forests.

### Teaching Suggestions

1. Explain what a watershed is. Ask students to visualize a mountain range divided into a series of connecting bathtubs (valleys). When rain falls on a ridge line, it will fall into one "bathtub" or another, and then drain to a stream at the bottom. Each "bathtub" or valley is a separate watershed.
2. Compare a barren mountain with the roof on a house: When it rains, most of the water washes right down the roof, flows through the gutter, and splashes onto the ground. Very little water remains on the roof, and the gutter (like a stream) becomes dry soon after the rain stops. The roof is the "watershed" for the gutter.
3. Interpret the watershed model for the class. The two graters represent mountain slopes separating two different watersheds and the holes are the pores in the ground. The small bowl is inside the mountain and represents the groundwater lens. The large pan is the ocean, and the blue water coming from the mist bottle is rain.
4. Explain that the grater "mountain" is unforested. Ask the class to predict whether most of the rain falling on this mountain will end up as groundwater in the bowl or as surface water in the ocean? Take a vote and record their predictions on the board.
5. Pump the mist bottle over the mountain about 80 times to simulate rainfall. Allow a few moments for the water to drain, and then pour

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the "groundwater" collected in the small bowl into the measuring cup. Ask a volunteer to read the amount collected and record the figure on the board. Then pour the water out and repeat the procedure with the "ocean" water that collected in the tray. Compare the amounts measured with the original predictions.

6. Discuss the results and ask students what they think will happen if spongy forest cover is added to the mountain. Attach sponges to the graters with rubber bands and repeat the experiment. Before measuring the amount of "groundwater" collected, squeeze the sponges into the "groundwater lens" or bowl to speed up the process of water percolating into the water table.

7. Again, compare the amounts of "seawater" and "groundwater" with the students' predictions. Emphasize the importance of forest cover in watershed management. Explain that in a real forest, some of the water stored would be used by plants.

8. Remind students that while forested watersheds will help provide a steady water supply, only wise water use and conservation will insure that the water supply continues to meet the needs of our growing population.

9. Ask students to draw a picture comparing rainfall on a forested slope and on a barren slope in Hawai'i and write captions for the pictures based on the results of the watershed experiment.

### Extended Activities

► Have students work in groups to create their own models of forested and barren watersheds. Shag carpet, towels, or moss can be used to represent the forest, while metal, plastic, or clay can represent barren slopes.

► Ask students to imagine what Hawai'i might be like now if responsible people hadn't bothered to reforest barren slopes years ago. They may use pictures, poems or stories to express their images.

► Generate a discussion about environmental responsibility. Point out that our water supply today is largely due to the foresight of people generations ago. Ask students how their attitudes and actions toward the environment today may affect the lives

of their grandchildren in the next century-

► Conduct a long-range experiment to see if there is much potential for fog drip in your area. Place two sturdy posts (about two meters long) approximately one meter apart in an elevated, vegetated area exposed to the wind. Pound the posts one-half meter into the ground, or until they feel stable. Stretch mosquito screen between the posts and staple it in place. Monitor how long it takes for a line of grass below the screen to appear greener due to greater water availability. Trees, of course, do a much better job of catching moisture in the air because they are taller, wider, sturdier, and multi-layered.

► On Arbor Day (in Hawai'i, the third Friday in November) lead the class on a tree-planting expedition. Trees can be planted on the school grounds, or in other community areas with the appropriate permission. Be careful about which tree species you plant. Native trees have many ecological advantages, but some are difficult to establish. Plants can be obtained from Arbor Day tree giveaway's or State (DOFAW) tree nurseries. If you choose an introduced species, make sure it is not a pest species (look at the State noxious weed list on the State Department of Agriculture's website if you're not sure: <http://www.hawaiiag.org/hdoa/adminrules/AR-68.pdf>).

► Take a class hike through a forested area and compare and contrast moisture, temperature, and other environmental conditions inside and outside the forest.

► Hold a school-wide paper drive. Explain how recycling paper saves trees. Donate money earned to a local, national or international organization that is working to save tropical rainforests, or use it to purchase seedlings and gardening tools for your own reforestation project.

► Ask students to interpret how the following four props represent beneficial effects of forests: a pump or spray mist bottle (cooling effects of transpiration from leaves), an umbrella (forest canopy intercepting water and protecting soil), a sponge (water-holding capacity contributing to groundwater supply), and an anchor (tree roots holding soil).